Treatment of desmoid tumors with magnetic resonance imaging guided high intensity focused ultrasound and cryoablation

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Experience to date

**Desmoid Tumors – 55 Patients**

- 53 treated successfully
- 91 treatments
Advantages of MR guidance

Targeting and safety
Advantages of MR guidance

Intra-operative verification using MR thermometry
Advantages of MR guidance

Post-treatment verification
Treatment of soft tissue tumors

Coronal  Axial

Pre-MRgHIFU

Post-MRgHIFU

Stanford University
Treatment of soft tissue tumors

Sarcomas

• IDE G130099
• NIH P01 CA15999203
Transition to desmoid tumors

- Soft tissue tumors are a heterogeneous group of tumors arising from connective tissues

- Natural history
  - Benign
  - **Benign, but locally aggressive**
  - Malignant
Treatment of desmoid tumors

- **Surgery**
  - Infiltrative tumor, so large resection needed to achieve negative margins

- **Radiation**
  - Reduce the rate of local recurrence
  - Treat unresectable tumors
  - Palliate pain

- **Conservative approach**
  - Aims to preserve function
  - Recurrence depends not only on positive margin but also on behavior of tumor
Surgical treatment of desmoid tumors
Radiation and desmoid tumors

- **Radiation**
  - Effective at controlling disease in about 80%
  - **BUT**
    - Less effective in children
    - 30% risk of significant complications
    - 5% risk of developing cancer
Clearly, there is an unmet clinical need

**STANDARD TREATMENT OPTIONS**
- Surgical resection
- Radiation therapy
- Chemotherapy
- Novel systemic treatments (targeted therapies)

**SIDE EFFECTS**
- Surgical morbidity
- Radiation burns, secondary malignancy, fibrosis, chronic edema
- Chemotherapy toxicity

**CLINICAL NEED**
- Decrease morbidity associated with treating soft tissue tumors
- Primary, recurrent, or palliative treatment
Methods
Methods
Methods
Methods
Methods: treatment plan
Methods: intra-operative thermometry
Methods: post-treatment evaluation
Summary of treatment results

- **55 PATIENTS: 39 WOMEN, 16 MEN**
- **91 TREATMENTS**
  - Treatments repeated in 24 (44%) patients to target residual viable tumor

<table>
<thead>
<tr>
<th>Patient age</th>
<th>Range</th>
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<tbody>
<tr>
<td>36 years</td>
<td>4– 66 years</td>
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<table>
<thead>
<tr>
<th>Follow-up</th>
<th>Range</th>
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<tr>
<td>11 months</td>
<td>0 – 47 months</td>
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Distribution of cases

- **Torso**
- **Proximal-UE**
- **Distal-UE**
- **Pelvis**
- **Proximal-LE**
- **Distal-LE**
<table>
<thead>
<tr>
<th>Summary of treatment results</th>
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<tbody>
<tr>
<td>Non-Perfused Volume Ratio*</td>
</tr>
<tr>
<td>Tumor volume, median</td>
</tr>
<tr>
<td>• Total, Pre-FUS</td>
</tr>
<tr>
<td>• Viable, Post-FUS</td>
</tr>
</tbody>
</table>

*relative to total tumor volume, on a per treatment basis
## Technical treatment parameters

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Range</th>
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<tbody>
<tr>
<td><strong>Treatment time</strong></td>
<td>3.8 ± 1.2 hours</td>
<td>1.0 – 7.9 hours</td>
</tr>
<tr>
<td><strong>Number of sonication per treatment</strong></td>
<td>83 ± 36</td>
<td>6 – 235</td>
</tr>
<tr>
<td><strong>Sonication energies</strong></td>
<td>1854 ± 1023 J</td>
<td>470 – 5889 J</td>
</tr>
<tr>
<td><strong>Average temperature per sonication</strong></td>
<td>59 ± 6 °C</td>
<td>48 – 74 °C</td>
</tr>
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</table>
OVERALL PAIN RELIEF

• Max: 6.9 ± 2.9 → 3.9 ± 2.9 (p < 0.0001)
• Avg: 3.8 ± 2.1 → 1.6 ± 1.8 (p < 0.0001)

COMMON THEME IN THOSE WITHOUT LOCAL CONTROL

• proximity to nerve, for example in popliteal fossa
• large tumor size
• proximity to skin
• scar from prior surgery
• mutation status?
**Clinical benefit**

**Durable clinical benefit of the MRgFUS treatments based on**

- Change in SF-36 scores (23 patients)

<table>
<thead>
<tr>
<th>SF-36 Category</th>
<th>Pre FUS</th>
<th>Post FUS</th>
<th>Change, per patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>72</td>
<td>80</td>
<td>6</td>
</tr>
<tr>
<td>Role limitations due to physical health</td>
<td>39</td>
<td>68</td>
<td>26</td>
</tr>
<tr>
<td>Role limitations due to emotional problems</td>
<td>71</td>
<td>90</td>
<td>16</td>
</tr>
<tr>
<td>Energy/fatigue</td>
<td>48</td>
<td>56</td>
<td>7</td>
</tr>
<tr>
<td>Emotional well-being</td>
<td>72</td>
<td>78</td>
<td>6</td>
</tr>
<tr>
<td>Social functioning</td>
<td>66</td>
<td>86</td>
<td>17</td>
</tr>
<tr>
<td>Pain</td>
<td>47</td>
<td>68</td>
<td>20</td>
</tr>
<tr>
<td>General health</td>
<td>66</td>
<td>64</td>
<td>-4</td>
</tr>
</tbody>
</table>
Clinical successes
Clinical successes
Clinical successes
Clinical successes
Clinical successes
Clinical successes
Clinical successes
**Treatment related adverse events**

- **Burns are the most common complication**
  - Have occurred in 23 of 55 patients (42%)
    - Six of these burns are CTCAE v5.0 - Grade 3
      - Required surgery
  - Nerve injury: n = 6
    - 3 recovered function,
    - 1 with numbness,
    - 1 with weakness,
    - 1 with neuropathic pain managed medically

- **Common theme in those with complications**
  - Proximity to nerve, for example in popliteal fossa
  - Large tumor size
  - Proximity to skin
  - Scar from prior surgery
Other experience with MRgFUS

DR. MATTHEW BUCKNOR – UNIVERSITY OF CALIFORNIA AT SAN FRANCISCO


DRS. SEAN TUTTON AND MICHEAL GRIFFIN – MEDICAL COLLEGE OF WISCONSIN


DRS. ALESSANDRO NAPOLI AND ALBERTO BAZZOCHI – ITALY


DR. KARUN SHARMA – CHILDREN’S NATIONAL MEDICAL CENTER

DR. JAMES GELLER – CINCINNATI CHILDREN’S HOSPITAL MEDICAL CENTER

Cooling system

Courtesy of Dr. Allison Payne, University of Utah
Grant from Focused Ultrasound Foundation
Cryoablation

Percutaneous Cryoablation of Extraabdominal Desmoid Tumors: A 10-Year Experience


<table>
<thead>
<tr>
<th>Tumor Response</th>
<th>No. (%) of Tumors</th>
<th>Follow-Up (mo)</th>
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<tbody>
<tr>
<td>No residual EAD tumor</td>
<td>9/23 (39.1)</td>
<td>26.6 ± 30.7*</td>
</tr>
<tr>
<td>Some volume reduction of EAD tumor</td>
<td>22/23 (95.7)</td>
<td>16.2 ± 20.0*</td>
</tr>
<tr>
<td>Progressive disease of EAD tumor</td>
<td>1/23 (4.3)</td>
<td>8.6</td>
</tr>
</tbody>
</table>

*Mean ± SD.
Percutaneous Image-Guided Cryoablation in Inoperable Extra-abdominal Desmoid Tumors: A Study of Tolerability and Efficacy


- On the first imaging study at 3 months, no residual enhancing mass was detected for nine lesions (53%).
- Of remaining 8 lesions, three increased during follow-up, including two associated with a recurrence of pain.
- The median change in tumor volume was estimated at -73.5% at 6 months (range -85 to -21%).
- During follow-up, two in situ recurrences were observed 6 months after the procedure.
Cryoablation of extra-abdominal desmoid tumours: initial experience and results

Cryoablation of extra-abdominal desmoid tumours: initial experience and results

Cryoablalation
Conclusion

Ablative approaches (MRgFUS/HIFU or Cryoablation)

- Provide an alternative treatment option to “standard” therapies
- Not all patients can be safely treated
- Complete tumor ablation is only achievable in a subset of patients
- Tumor size reduction and symptom improvement is possible even with partial treatment
- Tumors may regrow after partial treatment
- Although less invasive than surgery, there are risks with ablation
- Major impediment to access is difficulty in insurance authorization